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COMPLIANCE ANALYSIS IN FOOD AND NUTRITION UNITS, APPLICATION OF ARTIFICIAL INTELLIGENCE IN FOOD SAFETY

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ABSTRACT

The present study investigated the compliance of Food and Nutrition Units - UAN in the city of Curitiba, Paraná, using a formulated checklist, combined with predictive analysis through Artificial Intelligence - AI. The objective was to identify critical areas related to food safety and the well-being of workers. 159 UANs were evaluated, covering areas such as kitchen, service hall, bathrooms, outdoor area and Standard Operating Procedures - SOP. The data collection consists of 3,975 items observed, statistically analyzed and submitted to AI to identify patterns and predict risks. The main results indicated high levels of compliance in facility sanitization, with 92% and food storage accounting for 90%. However, concerns about inadequate ventilation stood out 20% and cleanliness of outdoor areas 22% non-compliant. With the analyses carried out by AI, strategic answers were obtained, demonstrating areas that need continuous improvement. It was concluded that the use of AI can optimize management practices and contribute to food security, proposing effective interventions and improving compliance in UAN.

Keywords: Good Practices. Food Security. Artificial intelligence. UAN. POP.

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Revista ARACÊ
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INTRODUCTION

Safe and quality food is a human rights issue, as it directly affects people's health and well-being. The initiative started from the need to transform the reality experienced in this segment into concrete actions of control and diagnostic survey within a Food and Nutrition Unit (UAN).

According to Silva and Chinelate (2020), training and monitoring of good practices are crucial for food safety, therefore, the proposal in this investigation was to implement and monitor good hygiene and food safety practices, which were essential to ensure that the food offered was completely in accordance with sanitary regulations, such as RDC n° 216, National Health Surveillance Agency. (ABERC, 2023)

This study was preceded by a "Restaurant Inspection Checklist", an analytical tool in a structured format, used to identify which areas needed attention and more. These inspections are carried out seasonally annually or according to the request of each UAN, ensuring their execution within an atmosphere that has respected the highest standards of food safety. Data collection was meticulously carried out, enabling a real-time diagnostic evaluation UAN that gave valuable information for safe management in each establishment.

In the collection of these quantitative data, special ethical care was taken to ensure that the information of any of the workers in the investigated units would not be exposed. The analysis of this information was carried out through statistical methods and Artificial Intelligence (AI), which not only made it possible to understand the current state of the scenario, but also previously indicated possible risks, suggested strategic improvements.

According to Oldroyd, Morris and Birkin (2021) this predictive approach is vital to identify certain situations of non-compliance, before they become problems, ensuring food safety as well as the effectiveness of operations.

The study was based on Brazilian standards, so the project had a solid and scientific basis. In this way, this study not only reaffirmed the importance of food safety but also made a significant contribution to the area of Nutrition, promoting a safer, more ecological practice and more in line with the real needs of the sector.

According to Andrade and Sturion (2015, p. 628) "the implementation of quality programs allows the improvement of the service provided, ensures the well-being of consumers, in addition to providing greater reliability and loyalty of services"

Revista ARACÊ
ISSN: 2358-2472

METHODOLOGY

The survey evaluated 159 UANs, being a sample of approximately 3.17% of the total of 5,014 restaurant companies and other food and beverage service establishments operating in the city of Curitiba in 2024 that were evaluated using an inspection checklist containing 25 observation items, distributed among the divisions of the UAN – kitchen, service hall, restrooms and outdoor areas and standard operating procedures, totaling 3975 items observed. The inspection checklist was based on the framework of RDC 216/2004, since it is focused on identifying critical risks to factors that are directly associated with food safety.

Artificial intelligence was applied to indicate compliance standards more efficiently, predict critical scenarios, and suggest areas of intervention. Descriptive statistics were adopted as the criterion of analysis, with the calculation of absolute and relative frequency used to provide detailed information on the safety standards of UANs.

According to Qian et al. (2022), AI applications in food safety include prediction of food safety risks, monitoring, optimization, early warning of outbreaks, and detection of foodborne pathogens. This analysis process using AI as a tool for data collection in the health area was approved by the Research Ethics Committee - CEP of the State University of Ponta Grossa - UEPG under protocol number 5.475.110.

DATA COLLECTION

The data collected over six months prioritized areas relevant to the UANs of Curitiba, consisting of 3975 items from 159 establishments, this detailed survey sought to ensure a detailed understanding of hygiene practices, food safety and compliance with current regulatory standards, highlighting the following areas and sectors of each UAN:

- Kitchen: equipment, ventilation, food storage.
- Service Room: tables and chairs, lighting.
- Bathrooms: cleanliness and hygiene.
- External Area: Environmental safety and cleanliness.
- SOPs: Cleaning of facilities, equipment and furniture, in general.

The UANs were evaluated based on whether or not they conformed to Good Manufacturing Practices and Standard Operating Procedures prescribed in the legislation. Compliance with the standards established by RDC216/2004 was classified as Compliant, Non-Compliant and Non-Applicable. (BRAZIL, 2004)

Revista ARACÊ
ISSN: 2358-2472

RESULTS

Intentionally, in the results presented, only the preponderant aspects were highlighted, with the purpose of objectively synthesizing all 25 items evaluated. Such an option not only aims to provide a reading that is as unbiased and direct as possible, but through an AI-supported predictive approach. With this, it is possible to efficiently apply the identification and prioritization of the most critical points, in order to cover, in a simplified way, the general results and sustain future actions in a strategic way.

CUISINE

Matthewson and Heacock (2017, p. xx) explain: "Methods for cleaning and sanitizing food contact surfaces (countertops) to prevent cross-contamination in restaurant kitchens."

As it is a critical area for food safety, the kitchen presented varied results in relation to the units investigated:

- Kitchen Equipment: The compliance obtained was 85.0%, that is, of the 135 UANs compliant. In relation to non-compliant ones, there were a total of 10.0% of UANs, that is, 16 units. In addition, 5.0% of those identified had to be classified as Not Applicable, represented by the remaining 8 UANs. In all, it can be identified that the non-compliance of certain equipment occurs, in many cases, due to the lack of preventive maintenance and its obsolescence.
- Ventilation: Presented 80.0% compliance, or 127 of the 159 UANs inspected, leaving 32 non-compliant. Ventilation, if inadequate, allows humidity in the place, providing the environment for contamination by fungi and bacteria, thus affecting the purpose of food safety.
- Food Storage: this area of the establishments was highlighted, with 90.0% compliance, corresponding to 143 items, and 16 items 10.0% of those classified as non-compliant, generally due to problems in labeling and temperature control, which are quite relevant, as it is essential in terms of food safety and surveillance.

ATTENDANCE HALL

The UANs evaluated about the compliance of the service hall showed positive results, but also areas that need to be adjusted, as can be seen below:

Revista ARACÊ
ISSN: 2358-2472

- Tables and Chairs: with a percentage of 87.0% of the UANs in compliance, representing 138 establishments, while those that do not comply, a percentage of 13.0%, that is, 21 units, outside and lacking regular maintenance in certain aspects of tables and chairs;
- Lighting: Lighting: the level of compliance reached 89.0% with 141 items accepted and 18 items 11.0% found to be non-compliant. The poor and declining quality of the lighting was the main reason for categorizing the elements of the items, as it can affect the functionality of the space and the safety and comfort of users. Maintaining proper lighting is a critical factor in ensuring an effective environment, so while the level of compliance has been comparatively high, regular analysis and maintenance are necessary to prevent failures and maintain an exceptional quality of service.

BATHROOMS

According to Barber and Scarcelli (2009), the cleanliness of bathrooms is a significant factor for consumer satisfaction in restaurants.

The bathrooms, which should be considered fundamental for health and safety, brought the following data:

- Cleanliness and hygiene: 90.0% compliance, with 143 items in compliance and 16 items 10.0% out of standards. While not a particularly high rate in percentage terms, these issues imply issues that threaten ongoing hygiene and safety for users. Proper maintenance of toilets is crucial to reduce the spread of pathogens and ensure a safe and appropriate environment. Thus, it is vital that most items require periodic inspections and corrective actions for the safety of everyone who uses these spaces.

OUTDOOR AREA

The outdoor area was the part that presented the most difficult challenges, specifically with cleaning and maintenance. Despite efforts to keep the environment in good condition, there were obvious deficiencies in need of correction, such as leftovers, food scraps and other waste, generating the accumulation of dirt in certain places. Therefore, this paradigm launches a continuous effort of daily work to be reviewed in terms of cleaning, which can be observed below:

Revista ARACÊ
ISSN: 2358-2472

- Environmental Safety - 82.0% compliance 130 UANs and 29 units 18.0% out of standard compliant, thanks to problems in emergency lighting.
- Cleanliness – There is 78.0% compliance, 124 of the establishments are satisfactory and 35 of the UANs, 22.0% are non-compliant, which shows failures in management, problems with waste and maintenance of facilities outside the traditional environment, accumulated garbage and not properly conditioned.

STANDARD OPERATING PROCEDURES (SOPs)

Essential to achieve sanitation and food security, SOPs performed well, with the following results:

- Cleaning of Facilities, Equipment and Furniture - There was 92.0% compliance in 146 of the units, this stood out as one of the strengths in the UANs evaluated with only 13 UANS, that is, 8.0% outside the standard.

This result shows that the units are committed to the food safety guidelines established by Resolution 216/2004 (BRASIL, 2004).

In addition, compliance with SOPs was higher than 92%, underscoring the importance of SOPs for food safety.

Frederico and Oliveira (2022) point out that if implemented correctly, the performance of SOPs indicates that they comply with food safety and operational efficiency in UANs.

DISCUSSION AND CONCLUSION

By utilizing AI in combination with hands-on inspections, the evidence collected was substantial and provides a complete overall report, noted here, on the risks and compliances found across all UANs.

The results showed that the integration of practical experience with AI predictive analytics allowed the identification of areas of high compliance, as well as the efficient identification of areas with significant problems, such as, in this study, the insufficient ventilation system and lack of cleanliness of the outdoor area, suggesting necessary interventions to better map the risks and ensuring food safety through continuous inspections in the food storage areas and food preparation areas.

The conclusions reached through AI-based experimental predictive analytics have had a significant impact. The method enabled an accurate and early assessment of the

Revista ARACÊ
ISSN: 2358-2472

comfort areas of compliance. Based on the results generated, it was possible to formulate a continuous optimization strategy, with an extra focus on preventive maintenance to avoid future non-conformities.

While most of the UANs evaluated were in accordance with basic regulations, some areas of high compliance require maintenance to avoid any potential food hazards. UANs also obtained a high average score in standard operating standards. The high level of compliance can be an indication of how much the managers and operators of these establishments in question are diligently fulfilling their work activities, but also signal that they are committed to improving and maintaining a safe and hygienic environment for the use by customers of these establishments.

The limitless variety of data gathered throughout this study indicates not only the commitment to ensuring the accuracy and completeness of the results, but emphasizes the need for a structured approach to address critical areas.

AI is a very effective innovation, since fully exercised it totally changes the world as it is currently seen. This new science enables a faster, more practical, and effective approach to the ideal for business, highlighting the strengths and speed of results. Therefore, the results found not only point to the virtues of UANs, but also provide a clear path for continuous improvement. This translates into better services, following the rules and procedures to protect customers from these and other UANs.

Revista ARACÊ
ISSN: 2358-2472

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Revista ARACÊ
ISSN: 2358-2472

APPENDIX

RESTAURANT INSPECTION CHECKLIST

Property Name: Address:

Area/Item	Inspection Description	Status (Compliant/Non-Compliant/NA)
Kitchen		
1. Kitchen equipment	Check that they are in good condition for use and cleanliness.	
2. Ventilation	Inspection of exhaust and ventilation systems.	
3. Food Storage	Check that food is stored in a safe and organized way.	
4. Contamination prevention	Evaluate food handling practices.	
5. Temperature	Monitor ambient temperature to ensure food and worker safety (unhealthy)	
6. Lighting in the kitchen	Check that the lighting is adequate and working properly.	
Service hall		
7. Conditions of tables and chairs	Ensure that they are clean and in good condition.	
8. Lighting	Check if the lighting is adequate, sufficient and working.	
9. Noise	Measure noise levels to ensure acoustic comfort.	
10. Accessibility	Check accessibility for people with disabilities.	
Bathrooms		
11. Cleanliness and hygiene	Assess cleanliness, hygiene, and availability of supplies.	
12. Operation of the toilets	Check that all equipment is operating correctly.	
Outdoor area		
13. Environmental security	Inspection of areas such as parking lots and entrances.	
14. Cleaning	Evaluate the cleanliness and organization of the external environment.	
Safety and emergency		
15. Collective safety equipment	Check that fire extinguishers and emergency exits are accessible.	
16. Individual safety equipment	Suitable shoe, frying hose, apron, full uniform	
17. Employee Training	Confirm that everyone has received safety and emergency training.	
Sustainability		
18. Waste management	Check recycling and waste disposal practices.	

Revista ARACÊ
ISSN: 2358-2472

Area/Item	Inspection Description	Status (Compliant/Non-Compliant/NA)
19. Power Consumption	Evaluate energy efficiency and use of renewable energy.	
Ergonomics and Environmental Comfort		
20. Work postures	Evaluate ergonomics in workstations, kitchens and customer service.	
21. General Temperature	Monitor temperature in different areas for overall comfort.	
SOPs required by RDC No. 216		
22. Sanitization of Facilities, Equipment and Furniture.	Check the procedures for cleaning and sanitizing food areas and equipment.	
23. Integrated Control of Vectors and Urban Pests	Confirm that preventive and corrective measures in pest control have been implemented	
24. Sanitization of the Water Tank	Check the cleaning and disinfection of water reservoirs to ensure their quality.	
25. Hygiene and Health of Handlers.	Attest to the personal and behavioral hygiene of handlers to avoid food contamination.	

Recommendations:	
Responsible for the Inspection:	